IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Appellants:	S. SHIRAYONE, et al.
Serial No:	10/791,856
Filed:	MARCH 4, 2004
Title:	METHOD FOR PROCESSING PLASMA PROCESSING APPARATUS
Group AU:	1792
Examiner:	Zeinab El Arini
Confirm. No:	5252

BRIEF ON APPEAL

Mail Stop: APPEAL BRIEF
Honorable Commissioner of
Patent and Trademarks
P.O. Box 1450
Alexandria, VA 22313-1450

November 3, 2008

Sir:

Appellants respectfully appeal the Decision by the Examiner in the Office Action mailed January 2, 2008, finally rejecting claims 1, 3, 8-10 and 13-17, all claims pending in the above-identified application. No claim stands allowed.

REAL PARTY IN INTEREST

The real party in interest for the above-identified application is Hitachi High-Technologies Corporation , the Assignment in connection therewith having been recorded in the U.S. Patent and Trademark Office with a recordation date of March 4, 2004, at Reel 015048, Frame 0817.

RELATED APPEALS AND INTERFERENCES

Upon information and belief, there is no known prior and/or pending appeals, interferences, or judicial proceedings known to Appellants, Appellants' legal representative or Assignee, which may be related to, directly affect or be directly affected by or have a bearing on the Board's decision in this pending appeal.

STATUS OF CLAIMS

Claims 1, 3, 8-10 and 13-17 are presently pending in the above-identified application. All of claims 1, 3, 8-10 and 13-17 stand rejected, and each of claims 1, 3, 8-10 and 13-17 constitute the subject matter of this appeal. No claim is allowed.

Claims 2, 4-7, 11 and 12 have been previously cancelled.

STATUS OF AMENDMENTS

No amendment on other paper (e.g., Request for Reconsideration) was filed subsequent to Final rejection, in the above-identified application.

SUMMARY OF CLAIMED SUBJECT MATTER

Of the claims on appeal, claims 1 and 3 are independent claims, each defining a method for cleaning a plasma processing apparatus. Of the dependent claims, all are dependent on claim 3. There are no dependent claim, which is dependent on claim 1.

Claim 1 defines a method for cleaning a plasma processing apparatus having (i) a plasma generating means for generating plasma within a processing chamber, (ii) a high-frequency power applying means for applying high-frequency power to an object to be processed, (iii) a processing chamber to which an evacuating device is connected and which has its interior evacuated, and (iv) a gas supply device for the processing chamber. Thus, claim 1 defines the apparatus which is being cleaned, such apparatus being shown, for example, in Fig. 1 and described in the paragraph bridging pages 9 and 10, and the first full paragraph on page 10, of Appellants' specification. As for the "means" defined in claim 1, note, e.g., the last paragraph on page 10 of Appellants' specification, together with Fig. 1 of Appellants' disclosure, for the plasma generating means; and the first full paragraph on page 11 of Appellants' specification, together with Fig. 1 of Appellants' disclosure, for the high-frequency power applying means for applying high-frequency power to an object to be processed.

The cleaning method recited in claim 1 includes steps of mounting a Si wafer on an electrode for holding the object to be processed; and while the Si wafer is mounted on the electrode, introducing a mixed gas of hydrobromic gas and chlorine gas into the processing chamber and generating plasma; and removing an aluminum fluoride deposit adhered to the interior of the processing chamber by applying the high-frequency power, produced by the high-frequency power applying means of the

cited apparatus, to the Si wafer. See, e.g., the last full paragraph on page 12; and from page 13, line 9, to page 14, line 12, of Appellants' specification.

Independent claim 3 defines a method for cleaning a plasma processing apparatus for generating a plasma in a vacuum container of the plasma processing apparatus and plasma processing a substrate placed on a substrate holder disposed within the vacuum container. The defined method includes providing a period for cleaning an aluminum fluoride deposit in the vacuum container by generating plasma containing chlorine gas and hydrobromic gas, and additionally an element that reacts with fluorine to create a gas-phase reaction product either each time after plasma processing a wafer or plural wafers or before and after plasma processing. Thus, claim 3 defines a method for cleaning specific apparatus including a vacuum container. Note that the processing chamber 1 shown in Fig. 1 and described, for example, in the paragraph bridging pages 9 and 10 of Appellants' specification illustrates such vacuum container.

Claim 3 is directed to that aspect of the present invention wherein, generally, the plasma contains, in addition to chlorine gas and hydrobromic gas, an element that reacts with fluorine to create a gas-phase reaction product. As can be appreciated from, for example, the last two full paragraphs on page 24 of Appellants' specification, according to various aspects of the present invention, an element that reacts with fluorine (e.g., Si) is supplied, the, e.g., Si removing the fluorine from the aluminum fluoride (AlF_x) and vaporizing it in the form of SiF_x. By supplying the, e.g., Si in the plasma, effects according to the present invention, of removing aluminum-based contaminants (e.g., AlF_x) in the processing chamber, are achieved. Note that the Si can be introduced, for example, from a wafer positioned on the substrate holder during the cleaning, and/or the Si atoms can be supplied by supplying, e.g., a $SiCl_4$

gas, as described, for example, in the paragraph bridging pages 32 and 33, and the first full paragraph on page 33 of Appellants' specification.

All of the remaining claims in the application, claims 8-10 and 13-17, are dependent on claim 3. Claim 8 recites steps of placing a Si wafer, with no patterns printed thereon, on the substrate holder when the plasma including chlorine gas and hydrobromic gas is discharged, and applying high-frequency power to the Si wafer through the substrate holder. Note, for example, Embodiment 1 on pages 9-14 of Appellants' specification, particularly the last two paragraphs on page 13, the paragraph bridging pages 13 and 14, and the first full paragraph on page 14 of Appellants' specification. By placing the Si wafer on the substrate holder, and applying the high-frequency power to the Si wafer, the Si wafer is etched, so as to introduce silicon into the plasma to form volatile substances (e.g., SiF_4) with fluorine of the aluminum fluoride, easily evacuated from the processing chamber, so that it becomes possible to remove the aluminum-based deposits.

Claim 9, also dependent on claim 3, recites steps of placing a Si wafer, with no patterns printed thereon, on the substrate holder when the plasma including chlorine gas and hydrobromic gas is discharged, similar to the first step recited in claim 8. As in claim 8, claim 9 also recites the step of applying high-frequency power to the Si wafer through the substrate holder, and claim 9 further defines the high-frequency power being applied, as corresponding to a frequency of 400 kHz and is equal to or greater than 0.01 W per unit area (1 cm^2) of the Si wafer. As for this applied frequency and power, note, for example, advantages achieved according to the present invention by application of high-frequency power to the Si wafer through the substrate holder, in Embodiment 2 on pages 14-17 of Appellants' specification. Note, in particular, the paragraph bridging pages 32 and 33 of Appellants' specification,

describing desirability of applying such frequency and power level in order to supply Si atoms to the plasma.

Claim 10, dependent on claim 3, recites that a ratio of an area of an earth to the area of an inner wall of the vacuum container in contact with plasma is 40% or more. In connection therewith, attention is respectfully directed to the paragraph bridging pages 25 and 26 of Appellants' specification, describing that it has been found that by expanding the earth area to 40% or more of the plasma contact area, the amount of chipping of the earth can be suppressed to an allowable level even when the bias power for cleaning is set to 80 W or higher.

Claim 13, also dependent on claim 3, recites that various other gases are supplied simultaneously with the chlorine gas and the hydrobromic gas contained in the plasma gas. As described in the next-to-last paragraph on page 33 of Appellants' specification, any of the gases as set forth in claim 13, supplied with the halogen-containing gases (chlorine and hydrobromic gas), provide an element that reacts with fluorine to create a gas-phase reaction product that can easily be evacuated from the vacuum container.

Claim 14, also dependent on claim 3, is directed to that aspect of the present invention wherein a period for generating plasma containing SF_6 is provided prior to the period for generating plasma with the chlorine gas and hydrobromic gas. Note, for example, the last full paragraph on page 33 of Appellants' specification. As described in the first full paragraph on page 27 of Appellants' specification, by generating the plasma containing SF_6, cleaning of carbon in the processing chamber can be achieved, so that the present method provides <u>both</u> cleaning of, e.g., AlF_3 <u>and</u> of carbon materials deposited as contaminants in the vacuum container of the plasma processing apparatus.

Claim 15, also dependent on claim 3, recites that the plasma containing chlorine gas and hydrobromine gas additionally contains Si, to create the gas phase reaction product; and claim 17, also dependent on claim 3, recites that the plasma containing chlorine gas and hydrobromic gas additionally contains $SiCl_4$ gas. Note, for example, the next-to-last paragraph on page 33 of Appellants' specification; note also Embodiment 6 on pages 28 and 29 of Appellants' specification, describing that it is possible to supply Si using $SiCl_4$ or other gases.

Claim 16, dependent on claim 3, recites that a portion of material constituting the vacuum container includes Si, with cleaning of the aluminum fluoride deposit in the vacuum container being performed using the chlorine gas and the hydrobromic gas. In connection with claim 16, note, for example, Fig. 5 of Appellants' disclosure and Embodiment 6 bridging pages 28 and 29 of Appellants' specification, disclosing that it is possible to use a material containing Si to form a portion of the vacuum container, e.g., Si being supplied by using a ring 201 made either of Si or SiC, for supplying Si for reaction with the, e.g., aluminum fluoride.

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A first ground of rejection to be reviewed on appeal is whether the subject matter of claims 1, 3, 8-10 and 13-17 are unpatentable under 35 USC 103 over JP 09-171999 or JP 2000-012515 or JP 11-186226, in combination with JP 07-130706 or JP 2001-308068 and JP 09-186143 and U.S. Patent No. 4,786,352 to Benzing.

A second ground of rejection for review on appeal is whether the subject matter of claims 1, 3, 8-10 and 13-17 are unpatentable under 35 USC 103 over JP 09-186143 in combination with Benzing.

A third ground of rejection to be review on appeal is whether the subject matter of claims 3, 10, 13, 14 and 16 are unpatentable under 35 USC 103 over Benzing.

Another issue to be reviewed on appeal is whether (assuming, arguendo, that the applied references establish a prima facie case of obviousness) the evidence of record in Embodiment 4 on pages 22-27 of Appellants' specification, and especially the results shown in Table 1 on page 23 thereof, establish unexpectedly better results achieved by the present invention so as to overcome any such prima facie case of obviousness.

ARGUMENTS

Introduction

It is respectfully submitted that the combined teachings of JP 09-171999 or JP 2000-012515 or JP 11-186226, in combination with JP 07-130706 or JP 2001-308068 and JP 09-186143 and U.S. Patent No. 4,786,352 to Benzing would have neither disclosed nor would have suggested the subject matter of claims 1, 3, 8-10 and 13-17 of the above-identified application.

In addition, it is respectfully submitted that the combined teachings of JP 09-186143 and U.S. Patent No. 4,786,352 to Benzing would have neither disclosed nor would have suggested the subject matter of claims 1, 3, 8-10 and 13-17. In this regard, as the references applied in the first paragraph (Arguments section) above, which include JP 09-186143 and U.S. Patent No. 4,786,352 to Benzing, would not have disclosed or suggested the subject matter of the claims on appeal, then certainly disclosures of a subset of such references would have neither disclosed or suggested the subject matter of the claims on appeal.

Furthermore, it is respectfully submitted that the teachings of U.S. Patent No. 4,786,352 to Benzing would have neither taught nor would have suggested the subject matter of claims 3, 10, 13, 14 and 16. In this regard, as the references set forth in the first two paragraphs in this Arguments section, which include Benzing, would not have disclosed or suggested the subject matter of claims 3, 10, 13, 14 and 16 on appeal, then certainly disclosure of Benzing, a subset of such references, would have neither disclosed or suggested the subject matter of the claims on appeal.

In addition, even assuming, arguendo, that the combined teachings of the applied references would have established a prima facie case of evidence, it is respectfully submitted that the evidence in Appellants' specification, in particular,

Table 1 and the experimentation in connection with therewith described on pages 22-27 of Appellants' specification, shows unexpectedly better results achieved according to the present invention utilizing a plasma gas species of HBr and Cl_2, together with Si being added to the plasma gas, especially from a wafer on a wafer holder, establishing unobviousness of the presently claimed invention.

The present invention relates to a method for cleaning a plasma processing apparatus, particularly useful in connection with cleaning a vacuum chamber having an aluminum fluoride deposit therein. Such deposit can cause problems if not cleaned, in that such deposit builds up and can have an effect on the plasma, and can also flake off and deposit on the substrate being processed, causing defective products and thus undesirably reducing yield.

It has been known that when a gas containing fluorine is used during plasma processing, aluminum fluoride is generated, which is a stable compound having low vapor pressure and which cannot be removed easily. Various methods for removing aluminum fluoride have been proposed. One method uses Cl_2 gas to decompose AlF_3 into $AlCl_3$, and another method proposed decomposing and removing AlF_3 using H_2O and Cl_2. As for these previously proposed cleaning methods, note the paragraph bridging pages 5 and 6 of Appellants' specification.

However, recently materials of the wafers, and gases used in the plasma processing, have been diversified, and the problem of deposits that cannot be removed by conventional plasma cleaning methods has become more significant. Note the last full paragraph on page 6 of Appellants' specification. Therefore, a more effective method for cleaning the reaction chamber is required, for enhancing throughput.

Against this background, Appellants provide a method wherein contaminants, such as deposits, in particular, deposits of aluminum fluoride, in the vacuum (processing) chamber of a plasma processing apparatus, can be safely and effectively removed in a short time, thereby avoiding reductions in throughput. It is emphasized that the present invention provides a cleaning method, for removing contaminating deposits of aluminum fluoride, difficult to remove from the processing chamber easily, simply and effectively, at relatively high speed. Appellants have found that by forming a plasma including a mixed gas of hydrobromic gas and chlorine gas, in apparatus in which a silicon wafer is placed on an electrode for holding the object to be processed, and with a high frequency power applied to the Si wafer; and/or wherein the plasma generated includes, in addition to hydrobromic gas and chlorine gas, an element (e.g., Si) that reacts with fluorine to create a gas-phase reaction product, such plasma can be used to remove aluminum fluoride deposits adhered to the interior of the processing chamber, effectively and in a short time period. Note, especially, Embodiment 1 on pages 9-14 of Appellants' specification.

As to removal of aluminum fluoride, attention is respectfully directed to the description in Appellants' specification from the paragraph beginning on page 24, through the paragraph bridging pages 24 and 25, of Appellants' specification. That is, the Si takes out the F from the aluminum fluoride (AlF_x) and vaporizes in the form of SiF_x, and the remaining Al reacts with Cl or Br and vaporizes in the form of AlCl or AlBr. Moreover, it is estimated that the hydrogen of HBr has an effect to help these reactions. Thus, as described in the last full paragraph on page 24 of Appellants' specification, by supplying Si while generating plasma containing Cl or Br, the aluminum fluoride, which was difficult to remove according to the prior art, can be removed speedily.

The present invention provides various techniques for supplying Si. Thus, a Si-containing gas can be supplied such that the plasma containing chlorine gas and hydrobromic gas additionally contains a silicon-containing gas ($SiCl_4$, in a specific embodiment). A portion of material constituting the vacuum chamber can be used for supplying the Si atoms. Moreover, a Si wafer can be mounted on an electrode in the processing apparatus (e.g., on the substrate holder), with silicon being introduced into the plasma from such silicon wafer.

In addition, and as a further feature of the present invention, Appellants have found that with various processing in the processing chamber in which the plasma is generated, carbon deposits may occur; and that such carbon deposits can be removed effectively and efficiently, by generating plasma containing SF_6, prior to generating the plasma containing the chlorine and hydrobromic gasses and additionally the element that reacts with fluorine (e.g., Si). Note, for example, the first full paragraph on page 27 of Appellants' specification.

REJECTION UNDER 35 USC 103 AS BEING UNPATENTABLE OVER JP 09-171999 OR JP 2000-0122515 OR JP 11-186226 IN COMBINATION WITH JP 07-130706 OR JP 2001-308068 AND JP 09-186143 AND U.S. PATENT NO. 4,786,352 TO BENZING

Claim 1:

It is respectfully submitted that the references as applied by the Examiner in the rejection set forth in Item 1 of the Final rejection mailed January 2, 2008, would have neither taught nor would have suggested such a method for cleaning a plasma processing apparatus as in claim 1, the method including mounting a Si wafer on an electrode for holding the object to be processed, and while the Si wafer is mounted on the electrode, introducing a mixed gas of hydrobromic gas and chlorine gas into the processing chamber and generating plasma, with aluminum fluoride deposit adhered

to the interior of the processing chamber being removed by applying high-frequency power to the silicon wafer.

Thus, the invention as set forth in claim 1 includes the combination of mounting a Si wafer on the electrode, with high-frequency power applied to the wafer, and use of a mixed gas of hydrobromic gas and chlorine gas, so as to enable speedy removal of aluminum fluoride. As will be shown in the following, it is respectfully submitted that this combination of features is not taught by any of the combinations of teachings as applied by the Examiner.

JP 09-171999 discloses a plasma cleaning treatment, subsequent to etching a laminated structure film which uses an organic film for patterning and which contains, inter alia, a barrier metal, the etching being conducted using a mixed gas plasma of BCl_3 and Cl_2. This patent document discloses that in order to remove the reaction product of the etching treatment, the inside of the etching treatment chamber is plasma-treated with H_2O gas, and then the inside of the etching treatment chamber is plasma-treated with a gas containing chlorine. After that, the inside of the etching treatment chamber is plasma-treated additionally with O_2 gas.

JP 2000-012515 discloses a plasma cleaning method for plasma etching apparatus, wherein the etching chamber is cleaned using a mixed gas of BCl_3 and Cl_2.

JP 11-186226 discloses a plasma cleaning method in a plasma processor, including a cleaning step with an oxygen gas plasma and a cleaning step with a mixed gas plasma of Cl_2 and BCl_3.

It is respectfully submitted that each of the primary references as applied by the Examiner in the Final rejection in Item 1 of the Office Action dated January 2, 2008, would have neither disclosed nor would have suggested such method as in the present claims, including the specific mixture of gasses as in claim 1, or wherein a Si

wafer is mounted on an electrode, as recited in claim 1, and while the Si wafer is mounted on the electrode the specific mixture of gasses is introduced and a plasma is generated, with removal of aluminum fluoride deposit by applying the high-frequency power to the Si wafer, as in claim 1, and advantages thereof.

It is respectfully submitted that the additional teachings of the secondary references applied by the Examiner in Item 1 on page 2 of the Office Action dated January 2, 2008, would not have rectified the deficiencies of any one of the primary references, such that the presently claimed invention in claim 1, as a whole, would have been obvious to one of ordinary skill in the art.

Thus, JP 07-130706 discloses a cleaning technique for removing a reaction product even in a vacuum state of a reactive chamber. When cleaning is carried out, a Cl_2 gas is supplied to a reactive chamber, and plasma is generated with the Cl_2 at a high-frequency voltage. This patent document discloses that the reaction product is changed into an $AlCl_3$ gas that has a high vapor pressure, which is vaporized easily and discharged easily through a discharge pipe 20.

JP 2001-308068 discloses a method of cleaning, for removing AlF_3 deposited on an inner wall of a chamber of an etching process, the method including a first step of performing H_2O plasma processing, and, following the first step, a second step of performing Cl_2 plasma processing, after executing an Al dry etching process.

Even assuming, arguendo, that the teachings of either of JP 07-130706 or JP 2001-308068 were combined with the teachings of any one of the primary references, such combined teachings would have neither disclosed nor would have suggested the specific combination of chlorine and hydrobromic gasses as in the present claims, or mounting a Si wafer on an electrode for holding the object to be processed and introducing the mixed gas while the Si wafer is mounted on the

electrode, with the aluminum fluoride deposit removed by applying the high-frequency power to the Si wafer, as in claim 1, and advantages thereof.

It respectfully submitted that the additional teachings of NO 09-186143 and Benzing would not have rectified the deficiencies of the teachings of the other references as applied by the Examiner in Item 1 on page 2 of the Office Action dated January 2, 2008, so as to render the presently claimed subject matter of claim 1 obvious under the requirements of 35 USC 103.

JP 09-186143 discloses plasma equipment and dry cleaning thereof in order to remove a semiconductor residual substance accumulating on internal parts of a plasma process chamber. Note paragraph [0001] of this patent document. This patent document discloses that the processing described therein cleans and controls accumulation using a single plasma activity dry-cleaning step using a mixture of chlorine and fluoride content gas by which oxygen or an atom-like oxygen content does not exist. This patent document discloses that the plasma gas reacts with an organic residual substance and a metal residual substance alternatively, volatilizing the accumulated residual substance and removing the substance through an exit port. See paragraph [0012] of this patent document. Note also paragraph [0018] of this patent document. See also paragraphs [0022] and [0023], describing that one of the gasses of the gas mixture used in the cleaning is a fluoride content gas like SF_6, NF_3, ClF, CF_4, CHF_3 and C_4F_8; and another gas is an organic chlorine content gas like Cl_2, HCl, BCl_3 and $SiCl_4$. Note paragraphs [0022] and [0023] of this patent document.

Benzing discloses cleaning devices used to remove deposits and/or contamination from processing chamber walls, and tooling and substrates within such processing chambers, the device and method including two or more electrodes that may be shaped as interleaving fingers and that are fixtured on the exterior of a

process chamber that is constructed primarily of dielectric material, RF power and ground potential being coupled to the electrodes. This patent discloses that by evacuating the chamber, admitting a cleaning gas and applying RF potential, a plasma is formed within the chamber; and by appropriate choice of the cleaning gas and configuration of the electrodes, either the interior walls of the chamber together with any tooling can be cleaned or the surfaces of substrates placed within the chamber can be cleaned. See the paragraph bridging columns 1 and 2 of this patent. Note also column 3, lines 41-49. See, further, column 4, lines 32-42, describing that the cleaning gas may be such known gasses as CF_4, CF_4 and O_2, C_2F_6, SF_6 or NF_3; and note also column 5, lines 25-36, describing that other cleaning gasses that yield a specie upon decomposition in a plasma which, upon reaction with the chamber wall deposits and/or contaminants, yields a volatile product, may also used, such as CF_3Cl, CF_3Br, CCl_4, BCl_3, Cl_2, HCl, HBr, O_2 or various combinations of the preceding gasses with themselves and/or inert gasses. Referring to column 4, lines 32-39, and with reference to Figs. 2 and 3, this patent discloses that for chamber cleaning, substrates 12 are removed from the quartz tube 14 and the base plate 18 is affixed to the front of the tube 14, making a vacuum tight seal, with cleaning gas being introduced into the tube 14.

It is emphasized that Benzing teaches many different gases which can be used as cleaning gasses in forming a plasma to clean inside a processing chamber.

However, in plasma processing apparatuses, gasses suitable for performing processes are introduced to a vacuum processing chamber (under a vacuum) formed of components suitable for performing processes on subject wafers to be treated, or to perform other necessary processes such as cleaning of inner walls of the processing chamber. It is important to introduce gases or materials suitable for performing the

processes desired in the plasma processing apparatus. It is respectfully submitted that it is impossible to complete any desired process, by randomly combining the gasses and components previously taught. This can be seen in the evidence of record, wherein a plasma gas of SF_6 or Cl_2 does not satisfactorily remove aluminum fluoride.

In order to appropriately perform specified processes, semiconductor manufacturers and semiconductor apparatus manufacturers are performing research and development regarding the variety, flow rate, pressure and method of introduction of the various gasses to be introduced to the chamber, the arrangement of apparatuses, components forming the apparatuses, etc. Slight differences in gas pressure or other parameters can be a difference between success and failure. Of course, a combination of gasses, ratios thereof and other various factors can influence the process.

It is respectfully submitted that merely that Benzing, et al. discloses various gases, or various combinations of these gasses, can be used, such would have neither disclosed nor would have suggested use of the gasses described therein in connection with the presently claimed invention, which removes an aluminum fluoride deposit adhered to the interior of the processing chamber when the specified mixture of gasses is used and by applying high-frequency power to the Si wafer, as in claim 1.

In addition, it is emphasized that according to Benzing the wafers are removed from the quartz tube for chamber cleaning. Even assuming, arguendo, that the teachings of Benzing would have directed one of ordinary skill in the art to introduce a mixed gas of hydrobromic gas and chlorine gas during cleaning, the teachings of Benzing as a whole, together with the teachings of the other applied references, would have neither disclosed nor would have suggested, and in fact would have taught away

from, mounting a Si wafer on an electrode for holding the object to be processed, and, while the Si wafer is mounted on the electrode, the mixed gas is introduced into the processing chamber and plasma generated, and an aluminum fluoride deposit is removed by applying the high-frequency power to the Si wafer.

Moreover, the Examiner has not pointed to a disclosure in Benzing of removing aluminum fluoride by applying the high-frequency power to the Si wafer; or, for that matter, the Examiner has not pointed to a disclosure of such removal by applying high-frequency power to the Si wafer in any of the references applied by the Examiner. As can be seen in Table 1 of Appellants' specification on page 23, use of another wafer material (SiO_2) would not provide advantages achieved by the present invention. It is respectfully submitted that Benzing, either alone or in combination with JP 09-171999, JP 2000-012525, JP 11-186226, JP 07-130706 and JP 2001-308068 and JP 09-186143 as applied by the Examiner, would have neither disclosed nor would have suggested the subject matter of claim 1, including the combination of gasses, together with the Si wafer mounted on an electrode for holding the object to be processed, and removing an aluminum fluoride deposit adhered to the interior of the processing chamber by applying high frequency power to the Si wafer.

Claim 3:

It is respectfully submitted that the teachings of the references applied against claim 3 in Items 1 and 2 on pages 2-4 of the Office Action mailed January 2, 2008, would have neither disclosed nor would have suggested such a method for cleaning a plasma processing apparatus as in claim 3, including providing a cleaning period by generating plasma containing chlorine gas and hydrobromic gas and additionally an element that reacts with fluorine to create a gas phase reaction product.

Teachings of references applied against claim 3 have been previously discussed. It is respectfully submitted that the teachings of the references as applied by the Examiner do not disclose, nor would have suggested, generating a plasma containing chlorine gas and hydrobromic gas during a cleaning treatment, together with an element that reacts with fluorine (e.g., silicon; note claim 15), to create a gas phase reaction product. It is respectfully submitted that none of the applied references teach or would have suggested, including in the plasma during the cleaning, and in addition to the chlorine gas and hydrobromic gas, the element that reacts with fluorine to create the gas phase reaction product. As can be appreciated, by providing a gas phase reaction product, the contaminant can easily be removed from the vacuum container.

Even assuming, arguendo, that the references, including Benzing, would disclosed generating plasma containing chlorine gas and hydrobromic gas in the period for cleaning, it is respectfully submitted that the teachings of the applied references do not disclose, nor would have suggested, additionally including in the plasma the element (e.g., Si) that reacts with fluorine. In this regard, the contention by the Examiner in the third paragraph on page 3 of the Office Action mailed January 2, 2008, that "the chamber may contain [Si]" (emphasis added), is noted. Note that the Examiner does not even allege that the apparatus does in fact contain silicon; clearly, the Examiner has provided no basis for a conclusion of inherency.

In any event, even assuming, arguendo, that a component of the apparatus contains silicon, such allegation does not establish that silicon therefrom is contained in the plasma, as in claim 3. It is respectfully submitted that the Examiner has not established a prima facie case of obviousness, with respect to the subject matter of claim 3, including wherein the generated plasma contains, in addition to chlorine gas

and hydrobromic gas, an element that reacts with chlorine to create a gas-phase reaction product.

Thus, it is respectfully submitted that the Examiner has not established that the combination of references on page 2 of the Office Action mailed January 2, 2008, would have disclosed or would have suggested the subject matter of claim 3, including that a plasma containing chlorine gas and hydrobromic gas is generated during a period for cleaning an aluminum fluoride deposit, much less that such plasma additionally contains an element that reacts with fluorine to create a gas-phase reaction product.

Claims 8 and 9:

Furthermore, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such method for cleaning a plasma processing apparatus as in the present claims, having features as in claim 3 as discussed previously, and, additionally, wherein the process further includes placing a Si wafer, with no patterns printed thereon, on the substrate holder, when the plasma including chlorine gas and hydrobromic gas is discharged, with high-frequency power being applied using Si wafer. Note prior arguments in connection with claim 1.

As discussed previously, initially, it is respectfully submitted that Benzing, applied in all of the prior art rejections in connection with claims 8 and 9, teaches away from mounting a Si wafer on the substrate holder. It is respectfully submitted that the teachings of the applied references do not disclose, nor would have suggested, the placing of a Si wafer on the substrate holder and applying high-

frequency power to the Si wafer through the substrate holder, for introducing Si to the plasma for effective cleaning (removing) aluminum fluoride, as discussed previously.

Claim 10:

It is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested the method for cleaning a plasma processing apparatus as in claim 10, including the features discussed previously in connection with claim 3, and, additionally, wherein a ratio of an area of an earth to the area of an inner wall of the vacuum container in contact with the plasma is 40% or more.

While the Examiner has rejected claim 10 over the references listed on page 2 of the Office Action mailed January 2, 2008, the Examiner has only pointed to JP 09-186143 as teaching "all [limitations] with the exception of using hydrobromic gas and the frequency as claimed". Moreover, the Examiner has not pointed to any portion of JP 09-186143 describing, inter alia, that feature of the present invention in claim 10, of the ratio of an area of an earth to the area of an inner wall of the vacuum container. It is respectfully submitted that the Examiner has not established obviousness of the subject matter of claim 10 with a general allegation that JP 09-186143 teaches all limitations except for using hydrobromic gas and the frequency. Moreover, from a full review of Benzing, it is respectfully submitted that this reference does not disclose, nor would have suggested, such a ratio of areas as recited in claim 10, and advantages thereof, in suppressing the amount of chipping of the earth, even when the bias power for cleaning is set to 80 W or higher, as described in the paragraph bridging pages 25 and 26 of Appellants' specification.

Claim 13:

It is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such a method for cleaning a plasma processing apparatus as in the present claims, having features as discussed in claim 3, and, moreover, wherein N_2, CO, CO_2, H_2 or SO_2 is supplied simultaneously with the chlorine gas and the hydrobromic gas contained in the plasma gas. See claim 13. As described in Appellants' specification and discussed previously, by additionally supplying one of the recited gasses, simultaneously with the halogen gas excluding fluorine, an element that reacts with fluorine to create a gas-phase reaction product is provided. Thus, as can be appreciated, the supplied element can be another element supplied from any of the gasses listed in claim 13.

The reference by the Examiner to gases supplied is set forth, for example, in the second full paragraph on page 3 of the Office Action mailed January 2, 2008, in connection with the teachings of Benzing. Such listed gasses in Benzing do not include any of the gases set forth in claim 13. It is respectfully submitted that the Examiner has not established obviousness of supplying one of the listed gases in claim 13 simultaneously with the chlorine gas and the hydrobromic gas and additionally the element that reacts with fluorine contained in the plasma gas, as claimed in claim 13, and advantages thereof, wherein the gases which can be provided to form a volatile product including the fluorine is increased.

Claim 14:

It is respectfully submitted that the combined teachings of references as listed on page 2 of the Office Action mailed January 2, 2008, would have neither disclosed nor would have suggested such method for cleaning a plasma processing apparatus

as in claim 14, having features as discussed previously in connection with claim 3, and, furthermore, wherein a period for generating plasma containing SF_6 prior to the period for generating plasma with the chlorine gas and hydrobromic gas, is provided. Utilizing such period for generating plasma containing SF_6 prior to the period for generating plasma with the chlorine and hydrobromic gasses, carbon contaminants can be avoided, as seen in the description in the first full paragraph on page 27 of Appellants' specification.

In the Final Office Action mailed January 2, 2008, the Examiner refers to no reference which provides a period for generating plasma containing SF_6 prior to the period for generating plasma with the chlorine and hydrobromic gasses, as in claim 14. Particularly in view of the advantages achieved thereby, it is respectfully submitted that the Examiner has not established a prima facie case of obviousness in connection with the subject matter of claim 14.

Claims 15 and 17:

It is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such method for cleaning a plasma processing apparatus as in the present claims, wherein the plasma containing chlorine gas and hydrobromine gas additionally contains Si, to create the gas phase reaction product, as in claim 15; or wherein such plasma additionally contains $SiCl_4$ gas (see claim 17). By including Si, in general, or $SiCl_4$ gas, in the plasma containing chlorine gas and hydrobromine gas, aluminum fluoride can easily and effectively be reacted with the silicon to volatilize the fluorine component for removing the aluminum fluoride as a contaminant.

In the Office Action mailed January 2, 2008, the Examiner, while rejecting claims 15 and 17 over the combination of references on page 2 thereof, refers to no portion of the applied references describing that the plasma containing chlorine gas and hydrobromine gas additionally contains Si, or additionally contains $SiCl_4$ gas. As is clear from Appellants' disclosure as discussed previously, the silicon reacting with the aluminum fluoride can be supplied by a gas. It is respectfully submitted that the applied references do not disclose such feature of the present invention, emphasizing that in column 5 of Benzing, various gasses are described including NF_3, CF_3Cl, CF_3Br, CCl_4, BCl_3, Cl_2, HCl, HBr and O_2, or various combinations of these gases with themselves and/or inert gasses, but no silicon-containing gas, in particular $SiCl_4$, is described; and this reference does not disclose, nor would have suggested, that the plasma utilized in cleaning contains Si.

Claim 16:

It is respectfully submitted that the teachings of the references as applied by the Examiner would have neither disclosed nor would have suggested such method for cleaning a plasma processing apparatus as in the present claims, having features as discussed previously in claim 3, and, additionally, wherein a portion of material constituting the vacuum container includes Si, and cleaning the aluminum fluoride deposit in the vacuum container is performed using the chlorine gas and the hydrobromic gas. According to this aspect of the present invention, the Si for reacting with the fluoride is supplied from material constituting the vacuum container, whereby the Si can be supplied without supplying additional structures (such as a Si wafer), and without supplying additional gasses to perform the process.

In connection with claim 16, the Examiner contends in the next-to-last paragraph on page 3 of the Office Action mailed January 2, 2008, that the chamber wall and the object to be cleaned "may contain" Si. "May" does not establish inherency. It is respectfully submitted that even as alleged by the Examiner, the Examiner has not established inherency in, e.g., the subject matter of claim 16, including generating plasma containing, inter alia, an element that reacts with fluorine to create a gas-phase reaction product, and wherein a portion of material constituting the vacuum container includes Si. With this structure, the silicon can easily and effectively be provided.

REJECTION OF CLAIMS 1, 3, 8-10 and 13-17 UNDER 35 USC 103 AS BEING UNPATENTABLE OVER JP 09-186143 IN COMBINATION WITH BENZING

Claim 1:

It is respectfully submitted that the combined teachings of JP 09-186143 and Benzing would have neither taught nor would have suggested such a method for cleaning a plasma processing apparatus as in claim 1, the method including mounting a Si wafer on an electrode for holding the object to be processed, and while the Si wafer is mounted on the electrode, introducing a mixed gas of hydrobromic gas and chlorine gas into the processing chamber and generating plasma, with aluminum fluoride deposit adhered to the interior of the processing chamber being removed by applying high-frequency power to the silicon wafer.

As indicated previously, the invention as set forth in claim 1 includes the combination of mounting a Si wafer on the electrode, with high-frequency power applied to the wafer, and use of a mixed gas of hydrobromic gas and chlorine gas, so as to enable speedy removal of aluminum fluoride. The combined teachings of JP 09-

186143 and Benzing would have neither taught nor would have suggested this combination of features.

JP 09-186143 and Benzing have been previously discussed.

Even assuming, arguendo, that the teachings of JP 09-186143 and of Benzing were properly combinable, such combined teachings would have neither disclosed nor would have suggested the combination of features of the present invention as in claim 1, including mounting a Si wafer on an electrode for holding the object to be processed, introducing the recited mixed gas including, inter alia, hydrobromic gas while the Si wafer is mounted on the electrode, and removing an aluminum fluoride deposit adhered to the interior of the processing chamber by applying the high-frequency power to the Si wafer.

In this regard, it is again emphasized that Benzing teaches removal of wafers from the quartz tube for chamber cleaning, and even in combination with the teachings of JP 09-09-186143 would have taught away from the use of the silicon wafer, with high-frequency power applied thereto when removing an aluminum fluoride deposit; and that such aluminum fluoride deposits can be removed speedily when utilizing the combinations of Si wafer with high-frequency power applied thereto, and mixture of gasses, as in claim 1.

Moreover, it is respectfully submitted that the combining of teachings of JP 09-186143 and Benzing causes the following problems. In the following, discussed will be independent performance of the process of JP 09-186143 and the process of Benzing. Thereafter, simultaneous performance of the processes of JP 09-186143 and Benzing will be discussed.

As a preliminary point, JP 09-186143 mainly relates to a plasma processing apparatus for etching aluminum metal. Therefore, originally, substantially no (or very

little) Si exists within the processing chamber. The wafers used in the disclosed processes are wafers covered by aluminum or other metal.

If JP 09-186143 is performed first and subsequently the process of Benzing is performed, JP 09-186143 teaches using gas containing fluoride (such as NF_3 and C_4F) and gas containing chlorine (such as Cl_2 and HCl) to generate plasma and perform cleaning. Therefore, even if Si resides in the processing chamber, the Si would be removed to the exterior of the processing chamber by reaction with fluorine and chlorine, producing the volatile gases SiF_4 and $SiCl_4$. In other words, the Si residing in the processing chamber would be removed, and thus no Si exists therein.

In addition, the aluminum reacts easily with fluorine, further generating aluminum fluoride; and since the wafers are covered with aluminum or other metals, no new Si will be supplied in the processing chamber. In such state, where no Si exists, and where aluminum fluoride exists, the use of hydrogen bromide gas and high frequency taught in Benzing does not result in the removal of aluminum fluoride, as in the present invention. This is because no Si exists in the processing chamber, and because Benzing does not teach using Si wafers.

If the process of Benzing is performed first and JP 9-186143 is performed subsequently, even if it is assumed that Si resides in the processing chamber, the Si would react with Br in the processing chamber to remove Si therefrom. In other words, the Si in the processing chamber would be easily removed, and, thus, no Si would exist in the chamber. Applying the procedure in JP 09-186143 subsequent to performing the process of Benzing would not result in the removal of aluminum fluoride as taught in the present invention, since no silicon exists in the processing chamber and since no new silicon is supplied.

As a third alternative, if the procedures described in JP 9-186143 and in Benzing were performed simultaneously to treat a processing chamber having aluminum fluoride deposits in the interior of the chamber, a gas containing chlorine, and hydrogen bromide gas, could be introduced to the chamber and power supplied to generate a plasma therein. Further, a wafer covered with aluminum or other metals is used. According to this combination, aluminum fluoride deposits exist in the processing chamber, but Si does not. In this state, since no Si exists in the processing chamber, the combination of JP 09-186143 and Benzing does not result in the removal of aluminum fluoride in the processing chamber. To the contrary, aluminum fluoride would be newly generated from the wafer covered with aluminum, resulting in an effect opposite to that achieved by the present invention; i.e., the combined teachings of these references would produce additional aluminum fluoride.

As can be appreciated from the foregoing, it is respectfully submitted that the combined teachings of JP 09-186143 and Benzing would have neither taught nor would have suggested the presently claimed invention, with a Si wafer on an electrode for holding the object to be processed and removing an aluminum fluoride deposit adhered to the interior of the processing chamber by applying high-frequency power to the Si wafer, as in claim 1.

Claim 3:

It is respectfully submitted that the teachings of JP 09-186143 and Benzing would have neither disclosed nor would have suggested such a method for cleaning a plasma processing apparatus as in claim 3, including providing a cleaning period by generating plasma containing chlorine gas and hydrobromic gas and additionally an element that reacts with fluorine to create a gas phase reaction product.

Teachings of JP 09-186143 and Benzing have been previously discussed.

It is respectfully submitted that the teachings of these references do not disclose, nor would have suggested, a cleaning period by generating a plasma containing chlorine gas and hydrobromic gas, together with an element that reacts with fluorine (e.g., silicon; note claim 15), to create a gas phase reaction product. As can be appreciated, by providing a gas phase reaction product, the contaminant can easily be removed from the vacuum container.

Note the previous discussion concerning deficiencies of the combined teachings of JP 09-186143 and Benzing, in the discussion of the rejection of claim 1, where (1) JP 09-186143 is performed first and Benzing is subsequently performed; where Benzing is performed first and JP 09-186143 is subsequently performed; and where JP 09-186143 and Benzing are performed simultaneously. The teachings of these references would have neither disclosed nor would have suggested providing a period for cleaning an aluminum fluoride deposit in the vacuum container by generating plasma containing both chlorine gas and hydrobromic gas, and additionally an element that reacts with chlorine to create a gas-phase reaction product either each time after plasma processing a wafer or plural wafers or before and after plasma processing, and advantages thereof as discussed previously.

The contention by the Examiner that JP 09-186143 "teaches all [limitations] with the exception of using hydrobromic gas and the frequency as claimed" is respectfully traversed. It is respectfully submitted that this reference does not disclose, nor would have suggested, providing a period for cleaning an aluminum fluoride deposit by generating plasma containing, in addition to chlorine gas and hydrobromic gas, the element that reacts with fluorine as in claim 3, and advantages thereof.

In connection therewith, the Examiner is respectfully requested to point out where JP 09-186143 "teaches all [limitations] with the exception of using hydrobromic gas and the frequency as claimed".

Even assuming, arguendo, that the references, including Benzing, would have disclosed generating plasma containing chlorine gas and hydrobromic gas in the period for cleaning, it is respectfully submitted that the teachings of the applied references do not disclose, nor would have suggested, additionally including in the plasma the element (e.g., Si) that reacts with fluorine. In this regard, the contention by the Examiner in the paragraph bridging pages 5 and 6 of the Office Action mailed January 2, 2008, that the chamber and object to be cleaned "may contain [Si]" (emphasis added), is noted. Note that the Examiner does not even allege that the apparatus does in fact contain silicon; clearly, the Examiner has provided no basis for a conclusion of inherency.

In any event, even assuming, arguendo, that a component of the apparatus contains silicon, such allegation does not establish that silicon therefrom is contained in the plasma, as in claim 3. It is respectfully submitted that the Examiner has not established a prima facie case of obviousness, with respect to the subject matter of claim 3, including wherein the generated plasma contains, in addition to chlorine gas and hydrobromic gas, an element that reacts with chlorine to create a gas-phase reaction product.

Thus, it is respectfully submitted that the Examiner has not established that the combination of references on page 2 of the Office Action mailed January 2, 2008, would have disclosed or would have suggested the subject matter of claim 3, including that a plasma containing chlorine gas and hydrobromic gas is generated during a period for cleaning an aluminum fluoride deposit, much less that such plasma

additionally contains an element that reacts with fluorine to create a gas-phase reaction product.

Claims 8 and 9:

Furthermore, it is respectfully submitted that the teachings of JP 09-186143 and Benzing would have neither disclosed nor would have suggested such method for cleaning a plasma processing apparatus as in the present claims, having features as in claim 3 as discussed previously, and, additionally, wherein the process further includes placing a Si wafer, with no patterns printed thereon, on the substrate holder, when the plasma including chlorine gas and hydrobromic gas is discharged, with high-frequency power being applied using Si wafer. Note prior arguments in connection with claim 1.

As discussed previously, initially, it is respectfully submitted that Benzing, applied in all of the prior art rejections in connection with claims 8 and 9, teaches away from mounting a Si wafer on the substrate holder. It is respectfully submitted that the teachings of the applied references do not disclose, nor would have suggested, the placing of a Si wafer on the substrate holder and applying high-frequency power to the Si wafer through the substrate holder, for introducing Si to the plasma for effective cleaning (removing) aluminum fluoride, as discussed previously.

Claim 10:

It is respectfully submitted that the combined teachings of JP 09-186143 and Benzing would have neither disclosed nor would have suggested the method for cleaning a plasma processing apparatus as in claim 10, including the features discussed previously in connection with claim 3, and, additionally, wherein a ratio of

an area of an earth to the area of an inner wall of the vacuum container in contact with the plasma is 40% or more.

The Examiner has only pointed to JP 09-186143 as teaching "all [limitations] with the exception of using hydrobromic gas and the frequency as claimed". However, the Examiner has not pointed to any portion of JP 09-186143 describing, inter alia, that feature of the present invention in claim 10, of the ratio of an area of an earth to the area of an inner wall of the vacuum container. It is respectfully submitted that the Examiner has not established obviousness of the subject matter of claim 10 with a general allegation that JP 09-186143 teaches all limitations except for using hydrobromic gas and the frequency. Moreover, from a full review of Benzing, it is respectfully submitted that this reference does not disclose, nor would have suggested, such a ratio of areas as recited in claim 10, and advantages thereof, in suppressing the amount of chipping of the earth, even when the bias power for cleaning is set to 80 W or higher, as described in the paragraph bridging pages 25 and 26 of Appellants' specification.

Claim 13:

It is respectfully submitted that the combined teachings of JP 09-186143 and Benzing would have neither disclosed nor would have suggested such a method for cleaning a plasma processing apparatus as in the present claims, having features as discussed in claim 3, and, moreover, wherein N_2, CO, CO_2, H_2 or SO_2 is supplied simultaneously with the chlorine gas and the hydrobromic gas contained in the plasma gas. See claim 13.

As described in Appellants' specification and discussed previously, by additionally supplying one of the recited gases, simultaneously with the halogen gas

excluding fluorine, an element that reacts with fluorine to create a gas-phase reaction product is provided. Thus, as can be appreciated, the supplied element can be another element supplied from any of the gases listed in claim 13.

The reference by the Examiner to gasses supplied is set forth, for example, in the second full paragraph on page 3 of the Office Action mailed January 2, 2008. Such listed gasses in Benzing do not include any of the gases set forth in claim 13. It is respectfully submitted that the Examiner has not established obviousness of supplying one of the listed gases in claim 13 simultaneously with the chlorine gas and the hydrobromic gas contained in the plasma gas, as claimed in claim 13, and advantages thereof, wherein the gases, which can be provided to form a volatile product including the fluorine, are increased.

Claim 14:

It is respectfully submitted that the combined teachings of JP 09-186143 and Benzing would have neither disclosed nor would have suggested such method for cleaning a plasma processing apparatus as in claim 14, having features as discussed previously in connection with claim 3, and, furthermore, wherein a period for generating plasma containing SF_6 prior to the period for generating plasma with the chlorine gas and hydrobromic gas, is provided. Utilizing such period for generating plasma containing SF_6 prior to the period for generating plasma with the chlorine and hydrobromic gasses, carbon contaminants can be avoided, as seen in the description in the first full paragraph on page 27 of Appellants' specification.

In the Final Office Action mailed January 2, 2008, the Examiner refers to no reference which provides a period for generating plasma containing SF_6 prior to the period for generating plasma with the chlorine and hydrobromic gasses, as in

claim 14. Particularly in view of the advantages achieved thereby, it is respectfully submitted that the Examiner has not established a prima facie case of obviousness in connection with the subject matter of claim 14.

Claims 15 and 17:

It is respectfully submitted that the combined teachings of JP 09-186143 and Benzing would have neither disclosed nor would have suggested such method for cleaning a plasma processing apparatus as in the present claims, wherein the plasma containing chlorine gas and hydrobromine gas additionally contains Si, to create the gas phase reaction product, as in claim 15; or wherein such plasma additionally contains $SiCl_4$ gas (see claim 17). By including Si, in general, or $SiCl_4$ gas, in the plasma containing chlorine gas and hydrobromine gas, aluminum fluoride can easily and effectively be reacted with the silicon to volatilize the fluorine component for removing the aluminum fluoride as a contaminant.

In the Office Action mailed January 2, 2008, the Examiner, while rejecting claims 15 and 17 over the combination of JP 09-186143 and Benzing, refers to no portion of the applied references describing that the plasma containing chlorine gas and hydrobromine gas additionally contains Si, or additionally contains $SiCl_4$ gas. As is clear from Appellants' disclosure as discussed previously, the silicon reacting with the aluminum fluoride can be supplied by a gas. It is respectfully submitted that the applied references do not disclose such feature of the present invention, emphasizing that in column 5 of Benzing, various gases are described including NF_3, CF_3Cl, CF_3Br, CCl_4, BCl_3, Cl_2, HCl, HBr and O_2, or various combinations of these gases with themselves and/or inert gases, but no silicon-containing gas, in particular $SiCl_4$, is described; and this reference does not disclose, or would have suggested, that the

plasma utilized in cleaning contains Si, this plasma creating the gas phase reaction product.

Claim 16:

It is respectfully submitted that the combined teachings of JP 09-186143 and Benzing would have neither disclosed nor would have suggested such method for cleaning a plasma processing apparatus as in the present claims, having features as discussed previously in claim 3, and, additionally, wherein a portion of material constituting the vacuum container includes Si, and cleaning the aluminum fluoride deposit in the vacuum container is performed using the chlorine gas and the hydrobromic gas. According to this aspect of the present invention, the Si for reacting with the fluoride is supplied from material constituting the vacuum container, whereby the Si can be supplied without supplying additional structures (such as a Si wafer) and without supplying additional gasses to perform the process.

In connection with claim 16, the Examiner contends in the paragraph bridging pages 5 and 6 of the Office Action mailed January 2, 2008, that the chamber wall and the object to be cleaned "may contain" Si. "May" does not establish inherency. It is respectfully submitted that even as alleged by the Examiner, the Examiner has not established inherency in, e.g., the subject matter of claim 16, including generating plasma containing, inter alia, an element that reacts with fluorine to create a gas-phase reaction product, and wherein a portion of material constituting the vacuum container includes Si. Under this structure, the silicon can easily and effectively be provided.

In addition, and especially in connection with claim 1, attention is respectfully directed to Embodiment 4 on pages 22-27 of Appellants' specification, and in

particular Table 1 on page 23 thereof. It is respectfully submitted that Table 1 shows unexpectedly better results achieved utilizing a mixed gas of hydrobromic gas and chlorine gas, with silicon wafer material on the wafer holder and bias power applied to the wafer. This Table 1, and the description of experimentation in connection therewith, constitutes evidence of unexpected results, and must be considered in determining patentability. See In re DeBlauwe, 222 USPQ 191 (CAFC 1984). In light of the unexpectedly better results achieved according to the present invention, shown in this Table 1, particularly relevant to the subject matter of claims 1, 8 and 9, it is respectfully submitted that Appellants have established patentability of the presently claimed subject matter.

REJECTION OF CLAIMS 3, 10, 13, 14 AND 16 UNDER 35 USC 103 AS BEING UNPATENTABLE OVER BENZING

Claim 3:

it is respectfully submitted that the teachings of Benzing, as applied in Item 3 on pages 4 and 5 of the Office Action mailed January 2, 2008, would have neither disclosed nor would have suggested such a method for cleaning a plasma processing apparatus as in claim 3, including providing a cleaning period by generating plasma containing chlorine gas and hydrobromic gas and additionally an element that reacts with fluorine to create a gas phase reaction product.

Teachings of Benzing have previously been discussed.

It is respectfully submitted that the teachings of Benzing would not have disclosed, nor would have suggested, generating a plasma containing chlorine gas and hydrobromic gas during a cleaning treatment, together with an element that reacts with fluorine (e.g., silicon; note claim 15), to create a gas phase reaction product. As can be appreciated, by providing a gas phase reaction product, the contaminant can easily be removed from the vacuum chamber.

Even assuming, arguendo, that the references, including Benzing, would disclosed generating a plasma containing chlorine gas and hydrobromic gas in the period for cleaning, it is respectfully submitted that the teachings of the applied references do not disclose, nor would have suggested, additionally including in the plasma the element (e.g., Si) that reacts with fluorine. In this regard, the contention by the Examiner in the third paragraph on page 3 of the Office Action mailed January 2, 2008, that "the chamber may contain [Si]" (emphasis added), is noted. Note that the Examiner does not even allege that the apparatus does in fact contain silicon; clearly, the Examiner has provided no basis for a conclusion of inherency.

In any event, even assuming, arguendo, that a component of the apparatus contains silicon, such allegation does not establish that silicon therefrom is contained in the plasma, as in claim 3. It is respectfully submitted that the Examiner has not established a prima facie case of obviousness, with respect to the subject matter of claim 3, including wherein the generated plasma contains, in addition to chlorine gas and hydrobromic gas, an element that reacts with chlorine to create a gas-phase reaction product.

Moreover, noting the many gasses disclosed in Benzing, it is respectfully submitted that the teachings of this reference would not have disclosed, nor would have suggested, the subject matter of claim 3, including the cleaning period by generating plasma containing chlorine gas and hydrobromic gas, in addition to the specified element that reacts with fluorine to create a gas phase reaction product, achieving advantages of the present invention as discussed previously.

Claim 10:

It is respectfully submitted that the teachings of Benzing would have neither disclosed nor would have suggested the method for cleaning a plasma processing apparatus as in claim 10, including the features discussed previously in connection with claim 3, and, additionally, wherein a ratio of an area of an earth to the area of an inner wall of the vacuum container in contact with the plasma is 40% or more.

In connection with claim 10, the Examiner refers to column 1, lines 54-57 of Benzing. This portion of Benzing discloses that it is an object of the invention therein to provide a device and method that is suitable for in-situ cleaning of substrates placed within process chambers prior to processing. It is not seen how such object would have disclosed, or would suggested, such a ratio of an area of an earth to the area of an inner wall of the vacuum container in contact with the plasma, as in claim 10. It is respectfully submitted that the Examiner has not established obviousness of the subject matter of claim 10 from the teachings of Benzing, or advantages thereof, in suppressing the amount of chipping of the earth, even when the bias power for cleaning is set to 80 W or higher, as described in the paragraph bridging pages 25 and 26 of Appellants' specification, as discussed previously.

Claim 13:

It is respectfully submitted that the teachings of Benzing would have neither disclosed nor would have suggested such a method for cleaning a plasma processing apparatus as in the present claims, having features as discussed in claim 3, and, moreover, wherein N_2, CO, CO_2, H_2 or SO_2 is supplied simultaneously with the chlorine gas and the hydrobromic gas contained in the plasma gas. See claim 13. As described in Appellants' specification and discussed previously, by additionally

supplying one of the recited gasses, simultaneously with the halogen gas excluding fluorine, an element that reacts with fluorine to create a gas-phase reaction product is provided.

The reference by the Examiner to gasses supplied is set forth, for example, in the second full paragraph on page 3 of the Office Action mailed January 2, 2008, in discussing teachings of Benzing. Such listed gasses in Benzing do not include any of the gases set forth in claim 13. It is respectfully submitted that the Examiner has not established obviousness of supplying one of the listed gases in claim 13 simultaneously with the chlorine gas and the hydrobromic gas contained in the plasma gas, as claimed in claim 13, and advantages thereof, wherein the gases which can be provided to form a volatile product including the fluorine is increased.

Claim 14:

It is respectfully submitted that the teachings of Benzing would have neither disclosed nor would have suggested such method for cleaning a plasma processing apparatus as in claim 14, having features as discussed previously in connection with claim 3, and, furthermore, wherein a period for generating plasma containing SF_6 prior to the period for generating plasma with the chlorine gas and hydrobromic gas, is provided. Utilizing such period for generating plasma containing SF_6 prior to the period for generating plasma with the chlorine and hydrobromic gasses, carbon contaminants can be avoided, as seen in the description in the first full paragraph on page 27 of Appellants' specification.

In the Final Office Action mailed January 2, 2008, the Examiner refers to no portion of Benzing which provides a period for generating plasma containing SF_6 prior to the period for generating plasma with the chlorine and hydrobromic gasses, as in

claim 14. Particularly in view of the advantages achieved thereby, it is respectfully submitted that the Examiner has not established a prima facie case of obviousness in connection with the subject matter of claim 14.

Claim 16:

It is respectfully submitted that the teachings of Benzing would have neither disclosed nor would have suggested such method for cleaning a plasma processing apparatus as in the present claims, having features as discussed previously in connection with claim 3, and, additionally, wherein a portion of material constituting the vacuum container includes Si, and cleaning the aluminum fluoride deposit in the vacuum container is performed using the chlorine gas and the hydrobromic gas. According to this aspect of the present invention, the Si for reacting with the fluoride is supplied from material constituting the vacuum container, whereby the Si can be supplied without supplying additional structures (such as a Si wafer) and without supplying additional gasses to perform the process.

In connection with claim 16, the Examiner contends in the paragraph bridging pages 5 and 6 of the Office Action mailed January 2, 2008, that the chamber wall and the object to be cleaned "may contain" Si. "May" does not establish inherency. It is respectfully submitted that even as alleged by the Examiner, the Examiner has not established inherency in, e.g., the subject matter of claim 16, including generating plasma containing, inter alia, an element that reacts with fluorine to create a gas-phase reaction product, and wherein a portion of material constituting the vacuum container includes Si. Under this structure, the silicon can easily and effectively be provided.

In addition, attention is respectfully directed to Embodiment 4 on pages 22-27 of Appellants' specification, and in particular Table 1 on page 23 thereof. It is respectfully submitted that Table 1 shows unexpectedly better results achieved utilizing a mixed gas of hydrobromic gas and chlorine gas. This Table 1, and the description of experimentation in connection therewith, constitutes evidence of unexpected results, and must be considered in determining patentability. See In re DeBlauwe, 222 USPQ 191 (CAFC 1984). In light of the unexpectedly better results achieved according to the present invention, shown in this Table 1, particularly relevant to the subject matter of claims 1, 8 and 9, It is respectfully submitted that Appellants have established patentability of the presently claimed subject matter.

CONCLUSION

It is respectfully submitted that the foregoing establishes that the teachings of the references as applied by the Examiner would have neither disclosed nor would have suggested the presently claimed subject matter. That is, It is respectfully submitted that the combined teachings of JP 9-17199 or JP 2000-012515 or JP 11-186226 in combination with the JP 07-130706 or JP 2001-308068 and JP 9-186143 and Benzing; or the combined teachings of JP 9-186143 and Benzing; or Benzing by itself, would have neither disclosed nor would have suggested the presently claimed subject matter, including the processing steps recited in claim 1 and providing the period for cleaning as in claim 3. It is respectfully submitted that there is no proper basis for rejecting the present claims under 35 USC 103. Accordingly, it is respectfully submitted that the rejection of claims as set forth in the Office Action mailed January 2, 2008, is in error, and the Honorable Board is respectfully requested to correct this error by reversing the rejection in due course.

The Appeal Brief fee in the amount of $540.00 is submitted herewith.

Please charge any shortage in fees due in connection with the filing of this paper to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (case No. 638.43608X00), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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CLAIMS APPENDIX

1. A method for cleaning a plasma processing apparatus having a plasma generating means for generating plasma within a processing chamber, a high-frequency power applying means for applying high-frequency power to an object to be processed, a processing chamber to which an evacuating device is connected and which has its interior evacuated, and a gas supply device for the processing chamber, said method comprising:

mounting a Si wafer on an electrode for holding the object to be processed,

while the Si wafer is mounted on the electrode, introducing a mixed gas of hydrobromic gas and chlorine gas into the processing chamber and generating plasma, and

removing an aluminum fluoride deposit adhered to the interior of the processing chamber by applying the high-frequency power to the Si wafer.

3. A method for cleaning a plasma processing apparatus for generating a plasma in a vacuum container of the plasma processing apparatus and plasma processing a substrate placed on a substrate holder disposed within the vacuum container, said method comprising:

providing a period for cleaning an aluminum fluoride deposit in the vacuum container by generating plasma containing chlorine gas and hydrobromic gas and additionally an element that reacts with fluorine to create a gas-phase reaction product either each time after plasma processing a wafer or plural wafers or before and after plasma processing.

8. The method for cleaning a plasma processing apparatus according to claim 3, further comprising:

placing a Si wafer, with no patterns printed thereon, on the substrate holder when the plasma including chlorine gas and hydrobromic gas is discharged; and

applying high-frequency power to the Si wafer through the substrate holder.

9. The method for cleaning a plasma processing apparatus according to claim 3, further comprising:

placing a Si wafer, with no patterns printed thereon, on the substrate holder when the plasma including chlorine gas and hydrobromic gas is discharged; and

applying high-frequency power to the Si wafer through the substrate holder, wherein the high-frequency power being applied corresponds to a frequency of 400 kHz and is equal to or greater than 0.11 W per unit area (1 cm^2) of the Si wafer.

10. The method for cleaning a plasma processing apparatus according to claim 3, wherein

a ratio of an area of an earth to the area of an inner wall of the vacuum container in contact with plasma is 40 % or more.

13. The method for cleaning a plasma processing apparatus according to claim 3, wherein

N_2, CO, CO_2, H_2 or SO_2 is supplied simultaneously with the chlorine gas and the hydrobromic gas contained in the plasma gas.

14. The method for cleaning a plasma processing apparatus according to claim 3, further comprising:

providing a period for generating plasma containing SF_6 prior to said period for generating plasma with the chlorine gas and hydrobromic gas.

15. The method for cleaning a plasma processing apparatus according to claim 3, wherein said plasma containing chlorine gas and hydrobromine gas additionally contains Si, to create the gas phase reaction product.

16. The method for cleaning a plasma processing apparatus according to claim 3, wherein a portion of material constituting the vacuum container includes Si, and cleaning the aluminum fluoride deposit in the vacuum container is performed using the chlorine gas and the hydrobromic gas.

17. The method for cleaning a plasma processing apparatus according to claim 3, wherein the plasma containing chlorine gas and hydrobromic gas, used in the cleaning processing, additionally contains $SiCl_4$ gas.

EVIDENCE APPENDIX

Embodiment 4 on pages 22-27 of Appellants' specification.

RELATED PROCEEDINGS APPENDIX

None.

fluoride measured with a crystal oscillator film thickness meter. As can be seen clearly in this chart, the removal rate of aluminum fluoride where no bias is applied was 1 nm/min, wherein the rate was 2.6 nm/min when a bias of 30 W was applied, 3.9 nm/min when a bias of 45 W was applied, and 4.7 nm/min when a bias of 60 W was applied, by which a significant effect was realized.

Generally when high-frequency voltage is applied to the wafer 106, the plasma potential varies according to the variation of the high-frequency voltage at the positive voltage side. On the other hand, on the front surface of the side wall of the processing chamber (effective earth portion), an ion sheath is formed according to the plasma. By the ion-assist effect in which the ions are accelerated by the electric field in the ion sheath and collide against the side wall of the processing chamber, the removal rate of aluminum-base deposits is increased.

As the high-frequency voltage applied to the wafer 106 increases, the variation of plasma potential is increased, and the ion-assist effect is enhanced. Therefore, it is estimated that by applying to the Si wafer the highest possible high-frequency power allowed by the apparatus, the rate for removing the aluminum-based deposits in the processing chamber is increased, and thus, a more effective dry etching is enabled.

Embodiment 4

Here, an example according to the present invention in which the conditions are varied in further detail will be described. The following tests were performed in order to directly measure

the degree of deposition of aluminum fluoride to the interior of the vacuum container 109. In order to have deposits adhere to the surface of the entrance window 110, thirteen Si wafers (diameter size 300 mm) were etched continuously in CF_4+Cl_2 discharge. Thereafter, various plasmas were generated in an attempt to remove the deposits 113. Then, the aluminum fluoride in the deposits adhered to the entrance window 110 was subjected to quantitative analysis using a fluorescent X-ray analysis method. The results are shown in Table 1.

Table 1

Relationship between cleaning conditions and amount of Al deposited on entrance window

plasma gas species	wafer material on wafer holder	bias power (W)	bias power per unit wafer area (W/cm^2)	relative amount of aluminum fluoride (%)
no cleaning				100
SF_6	Si	20W	0.028	100
Cl_2	SiO_2	20W	0.028	100
Cl_2	Si	0W	0.028	90
Cl_2	Si	20W	0.028	50
Cl_2	Si	40W	0.056	17
Cl_2	Si	80W	0.11	7
$HBr+Cl_2$ (1:1)	Si	80W	0.11	1

Table 1 shows the amount of residual aluminum fluoride or effect of the cleaning in relative values in which the amount of deposited aluminum fluoride after processing thirteen wafers is shown as 100. The cleaning was performed for 360 S. From table 1, it can be seen that aluminum fluoride cannot be cleaned

by SF_6. Further, if SiO_2 wafer (Si wafer having its surface covered with SiO_2) is placed on the wafer holder, the aluminum fluoride cannot be cleaned using Cl_2. Further, even if Si wafer is placed on the wafer holder, the effect of cleaning is little when no bias power is applied to the wafer. By placing an Si wafer and by applying 20 W of bias power, the amount of aluminum fluoride is reduced to half, which means that cleaning is performed. The reason why the effect of cleaning is enhanced by applying bias to Si, other than the sputtering effect of the wall mentioned earlier, is as follows. The etching of the Si wafer is scarcely performed when the bias is 0W, but with a bias of 20 W, the etching rate is approximately 30 nm/min. That is, by applying bias, the amount of Si being supplied is increased, and the effect of the cleaning is enhanced. By adding HBr to Cl_2, the cleaning effect is even further enhanced.

The reason why aluminum fluoride can be removed by supplying Si is because, as mentioned earlier, the Si takes out the F from the aluminum fluoride (AlF_x) and vaporizes in the form of SiF_x, and the remaining Al reacts with Cl or Br and vaporizes in the form of AlCl or AlBr. It is not clear why the cleaning effect is enhanced when HBr is mixed in, but it is estimated that H has an effect to help the above reaction.

As explained above, by supplying Si while generating plasma containing Cl or Br, the aluminum fluoride, which was difficult to remove according to the prior art, can be removed speedily.

When the bias power is increased too much to supply Si,

the sputtering rate of the earth is also increased undesirably. According to the prior art method, during cleaning, either the Si wafer is not placed on the wafer holder or bias is not applied to the placed Si wafer, so as to suppress discharge of Si and chipping of earth. This drawback is overcome as follows. First, the minimum necessary amount of discharge of Si was seeked. It has been found through experiments that the bias applied to a dummy wafer of 300 mm should be within 20 W (0.028 W/cm^2) to 80 W (0.11 W/cm^2) to achieve sufficient cleaning effects. By setting the bias power within this range, unnecessary earth chipping can be suppressed, and aluminum fluoride can be removed without supplying excessive Si. When the size of the Si wafer differs, the bias power per unit area is determined accordingly.

Since the amount of Al being deposited during etching differs according to fluorine gas pressure (number of fluorine atoms) and bias power, the Si required for cleaning may be insufficient with the above-mentioned bias power (80 W). In order to solve this problem, the area of the earth was expanded. The earth 111 is a conductor having an impedance allowing bias high-frequency power to pass therethrough, which is disposed on the inner wall of the vacuum container 109 in contact with plasma 108. The plasma is normally generated between the wafer holder 107 and the entrance window 110. The area of the earth was expanded by adjusting the quarts inner cylinder 114. As a result, it has been found that by expanding the earth area to 40 % or more of the plasma contact area, the amount of chipping

of the earth can be suppressed to an allowable level even when the bias power for cleaning is set to 80 W or higher. The quartz inner cylinder is disposed so as to prevent dispersion of heavy metal contamination such as Fe contained in small quantities in aluminum or alumite. Therefore, reducing of size of the quartz inner cylinder may cause another problem of increase of heavy metal contamination, but this problem can be overcome by reducing the amount of heavy metal in the alumite to 0.1 % or smaller. In the apparatus illustrated in FIG. 3, a material formed by anodizing the surface of aluminum (alumite) is used as the earth. The thickness of the alumite must be set to 200 μm or smaller when the frequency of the bias power being supplied is 400 kHz. That is, the thickness should be set to 0.5f μm or smaller when the frequency is f kHz. Furthermore, if the metal of the chamber is coated by a material other than alumite, the coating must have a thickness equal to or less than the thickness corresponding to the impedance of the above-mentioned alumite capacity.

It is also possible to suppress chipping of the earth by providing a period called breakthrough where bias power is set high (for example, over 80 W) for about 5 to 20 seconds at the start of the cleaning process, and thereafter, reduce the bias power to less than 80 W. The function of the breakthrough is to remove the surface layer such as the naturally oxidized layer formed on the surface of the dummy wafer that cannot be removed easily by low-bias power, so that after the bias power is turned low, the Si surface can be etched to supply sufficient Si.

Moreover, it is also possible to mix approximately 2 % to 10 % oxygen to the cleaning gas, so that the earth is oxidized while cleaning is performed.

The above-described cleaning method aims at removing aluminum fluoride, but if a gas containing carbon, such as CF_4, is used as the etching gas, deposits containing carbon are generated at the same time. In such a case, by cleaning the carbon before cleaning the aluminum fluoride, the cleaning rate of aluminum fluoride is improved. It is effective to use a mixed gas containing SF_6 and oxygen or SF_6 to perform cleaning of carbon. By use of such gases, carbon can be removed by compounds of CS or CO.

Embodiment 5

Next, the details of a halogen gas that reacts with Al are described. Though it is possible to use a Cl_2 gas by itself or HBr gas by itself, the effect of removing aluminum fluoride was greatest when the mixture ratio of HBr in Cl_2 was 30 % to 80 %. Moreover, as shown in Table 2, the effect was greatest when the pressure was 2 Pa or greater.

Table 2

Relationship between cleaning conditions and amount of Al deposited on entrance window

plasma gas species	wafer material on wafer holder	bias power (W)	pressure (Pa)	relative amount of aluminum fluoride (%)
no cleaning				100
Cl_2	Si	20W	0.4	78